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INCREASED USE OF ISOTOPES IN HUNGARY

by Sandor Szalay

Hungary is in need of synthetic radioactive isotopes for research in its highly developed branches of organic chemistry and biochemistry. No synthetic isotopes have yet been used in Hungary, and Hungarian researchers still have not adopted the general use of radioactive tracers. Some time ago, Lajoa Imre and his co-workers performed successful experiments in detecting natural radioactive isotopes by ionization and electrostatic measurements.

The first use of the Geiger-Mueller counter in biological experiments was reported by Sandor Szalay at the 1950 Biological Congress in Szeged. Further research, using radioactive lead and bismuth, is being carried on at the Debrecen University Experimental Physics Institute in coordination with other institutes of the university. These experiments are rather modest in comparison with research in other countries, but they are encouraging.

Radium mixed with beryllium is used as a neutron source, one gram of radium plus 10 g of beryllium giving off approximately 1.7×10^7 neutrons per second. A small research group needs at least 100 mg of radium, and at least 500 - 1,000 mg are needed for experiments with animals and other serial experiments using radioactive tracers. Because of the harmful effects of gamma radiation, personnel making up radium preparations must be changed frequently and precautionary measures taken, such as using protective lead shielding in conjunction with sensitive X-ray detectors.

A laboratory for the preparation of radioactive substances, and equipped with the necessary radiation-protection devices, has been installed at the Experimental Physics Institute. Since radium is needed for many other purposes, the small amount available cannot be processed for use as a radium-beryllium neutron source and is kept in the form of a solution. Although a few extraordinary requirements for special radioactive substances can be met, routine synthesis of isotopes in Hungary is impractical. Action has already been initiated to secure radium-beryllium neutron sources needed for isotope synthesis.

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In the opinion of the author, Hungary's proportionately limited research facilities should be concentrated at one location, and researchers at other institutes should be granted fellowships to work at the specially equipped institute. This collection of radioactive material is already showing progress, although it is apparent that the total amount will be slight.

In the synthesis of isotopes, atom-bombarding apparatus are much more effective than radium-beryllium. Some X-ray-apparatus parts, available commercially, may be used in the production of neutrons by bombarding deuterium with a 280-kv, 0.1-ma deuteron ray (${}_1D^2$ plus ${}_1D^2 = {}_0n^1$ plus ${}_2He^3$), which gives a radiation equal to that of a radium-beryllium mixture containing 20 g of radium. The production of the deuteron-ion ray and preparation of high-voltage emission-tubes and high-velocity vacuum pumps are difficult but not insurmountable problems. Such a midget neutron generator has been under construction for the past few years at the Debrecen institute. The greatest hindrance to the progress of the construction is the institute's overburdened instruction schedule. Once the generator begins to function, a very slight amount of deuterium will be available; but when that is consumed the supply of heavy water will be a limiting factor in the generator's operation. At present, heavy water is not available in the international market, and no heavy water is produced in Hungary.

Because of the very high voltages necessary to produce high-intensity neutron rays, commercial X-ray-apparatus parts cannot be used. The Zoltan Bay experiments, which were performed some time ago at the Technical University in connection with the construction of a 2-million-cascade generator, were unsuccessful. A 1.5 - 2 million-v Van de Graaf static generator is under construction in a specially constructed wing of the Debrecen University Experimental Physics Institute. A Van de Graaf generator producing more than 2 million v would have to function in a vacuum chamber, the construction of which would be very expensive and require much special technical knowledge. The 2-m-diam metal sphere of the generator under construction will be suspended from the ceiling of a 9-m-high room. Such a generator is within the scope of Hungary's industry and her technical resources. Except for some loss of time, no great difficulties have been encountered so far in its construction. The greatest problems will be the preparation of the 4.5 - 5-m-long emission tube and the oil-vapor, high-velocity vacuum pump.

At present, it is technically impossible for Hungary to build even a medium-sized cyclotron. Besides the materials needed and the necessary know-how, the expense of construction of an instrument such as the cyclotron at the University of Zurich is prohibitive. The Zurich cyclotron has 95-cm-diam poles, a magnet requiring 40 tons of high-quality steel, a magnetizing current of 800 a and 200 kw, and accelerating hemicylinders actuated by a 40-kw electronic high-frequency generator. The cyclotron produces a 30-million electron-v alphaparticle, a 15-million electron-v deuteron, or 7.5-million electron-v proton ray. The electricity consumed would cost several hundred forints per hour. On a basis of 8 hr per day, 300 days per year, this would run into a million forints for electricity alone. The particular problems of supplying a cyclotron with electricity would necessitate laying a special line from the power center directly to the cyclotron site. Also, it takes a group of experts and specialists, working together constantly, to operate the cyclotron. The annual cost of operating a small cyclotron is comparable to the cost of maintaining a small college for a year.

The argument against using radium-beryllium as a neutron source, namely, that it is impractical in synthesizing some isotopes, also applies to the cylotron. Thus C^{14}, an isotope used extensively in biological research, can be synthesized practically only in the atomic pile. The author considers it superfluous to mention the prohibitive expense, in addition to the store of knowledge and the numerous atomic experts needed for the preparation and operation of an atomic pile.

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Besides the problem of obtaining the necessary isotopes, another problem of radiochemists is the tedious process of measuring accurately the radioactivity of large numbers of mildly radioactive preparations. One method for the determination of possible selective accumulation of compounds in biological tissue is to take radioautographs of microscopic tissue sections.

Electronic instrument parts of an apparatus designed at the Debrecen University Experimental Physics Institute for use in biochemical research with radioactive tracers could be manufactured in Hungary. The main features of the apparatus are an aluminum-foil-end-window counter tube installed in a thick lead cylinder, into which acid-oxidized, infrared-ray-dried samples of organic material are inserted. The rate of radiation is shown on a dial indicator developed at the institute, which utilizes an alarm-clock-principle mechanism and is capable of counting one impulse per 280th of a second, or counting 100 statistically distributed impulses per second. Another device recently developed in Hungary can count 1,200 evenly spaced impulses per second.

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